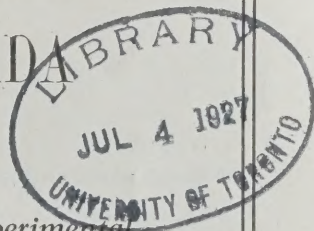


THE
COMBINED REAPER-THRESHER
IN WESTERN CANADA



*Results of experiment at the Dominion Experimental
Station, Swift Current, Saskatchewan, together with
reports from owners*

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DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
PAMPHLET No. 83—NEW SERIES

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The Combined Reaper-Thresher

During the past ten years there has been a great increase in the use of the Reaper-Thresher; a machine variously known as the "Combine," the "Harvester-Thresher," the "Reaper-Thresher" and the "Combined Reaper-Thresher." Throughout this bulletin the word "Combine" alone will be used to designate all types of this particular machine, the outstanding feature of which is, that it cuts and threshes grain in one operation.

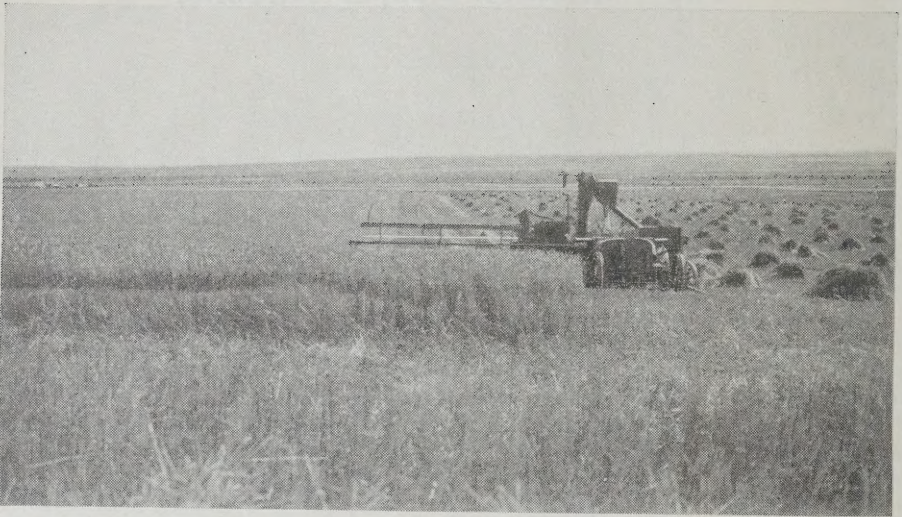
The machine, as its name implies, unites the functions of the binder and the separator, but eliminates the binding attachment of the binder, and the feeder and blower of the separator. The grain is cut at whatever height is necessary to get all the heads. The heads are conveyed to the cylinder by means of belts and slat conveyers. All the threshing mechanism is similar to that of the separator, except that the straw is deposited in a windrow behind the machine or scattered uniformly over the ground by a straw-spreading attachment. The threshed grain runs from a spout into a wagon attached to the combine.

In the larger type of combine, cutting fifteen to twenty feet, the cutting and threshing mechanism is operated by an engine mounted on the frame of the machine. This type of combine is drawn either by horses or a tractor. A smaller combine, cutting nine to ten feet, is drawn by a tractor and the mechanism is operated by a power take-off from the tractor.

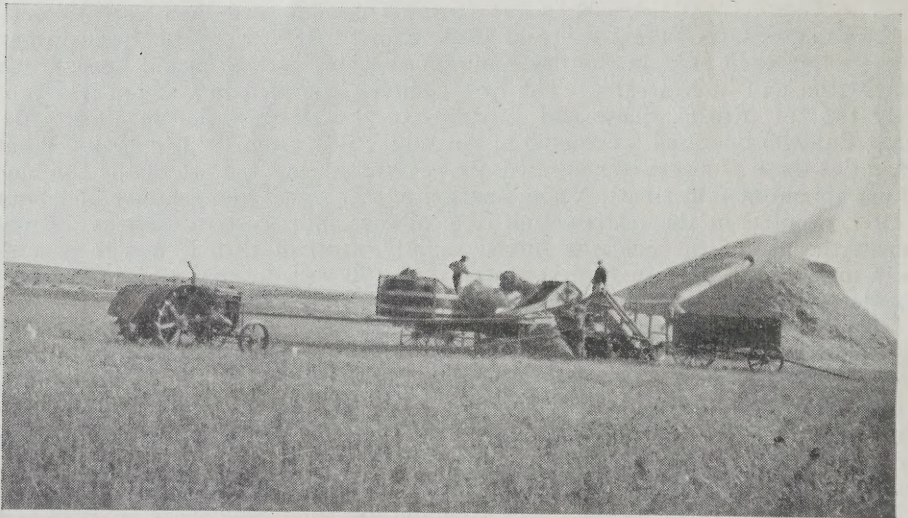
The first authentic record of the combine is contained in a patent issued by the United States Patent Office in 1828. Not till 1890 were they used in any numbers and then only in the dry mountain regions of California, Oregon and Washington and in Australia. The first combine operated in Canada was probably that of Messrs. Shaw and Edwards of Spy Hill, Sask., in 1908. Mr. Curtis Baldwin operated a combine at Aneroid, Sask., from 1913 to 1919. What difficulties these pioneers encountered are not known, but the use of the combine did not spread at that time. A combination of war prices and scarcity of labour in 1917 resulted in the introduction of combines into western Kansas. From Kansas the use of the machine spread rapidly, until in 1926 it was in general use in most of the western Prairie States, over 170 were in operation in Western Canada and a few were in use in Illinois, Ohio and Pennsylvania.

The Dominion Government, in co-operation with the Massey-Harris Co., Ltd., placed a twelve-foot motor-driven combine on the Experimental Station at Swift Current, Sask., in 1922. The primary consideration, in so doing, was to determine whether or not the combine could possibly be used economically in the drier districts of Western Canada. At that time the machine was coming into general use in the short-grass regions of Kansas and states farther south. It was commonly believed that the shorter seasons in the Northern States and Canada would prohibit its use. The combine did such good work in 1922 and gave such promise of being able to harvest grain crops economically that it was immediately purchased by the Experimental Farm and used each year since.

The machine harvested in 1922 an area of 30 acres on the Dominion Experimental Station at Swift Current, and 100 acres on a privately-owned farm nearby. No trouble was experienced in operation and the grain kept without loss in grade or in milling quality.



The combine method of harvesting.



Common method of threshing.

Since 1923 a series of experiments with the combine has been under way on the Dominion Experimental Station at Swift Current, Sask., to determine the following points:—

1. Costs of operation.
2. Stage of maturity of grain for successful operation of the combine.
3. Amount of grain lost by the combine compared with that lost by the binder and separator.
4. The acreage that can safely be harvested by the combine in any season.
5. The milling and baking qualities of wheat harvested by the combine.

COSTS OF OPERATION

A sixteen-foot machine drawn by twelve horses at the rate of two miles per hour would cut 38.8 acres in a ten-hour day. The time lost while shifting wagons, oiling the machine and other causes would probably reduce this amount to 35 acres per day. A similar machine drawn by a tractor at the rate of two and one-half miles per hour would cut 48.5 acres per day. Making due allowance for time unavoidably lost, the probable daily cut would be about 43.5 acres per day. The following estimates of costs are based on these acreages and on the following items:—

(a) Initial cost (sixteen-foot machine)	\$2,600 00
(b) Annual depreciation (estimated)	10%
(c) Interest on investment	8%
(d) Annual repairs (estimated)	50 00
(e) Days in operation per season	20

COST PER DAY OF A SIXTEEN-FOOT COMBINE WHEN DRAWN BY A 15-30 TRACTOR, CUTTING 43.5 ACRES PER DAY AND OPERATING 20 DAYS PER SEASON

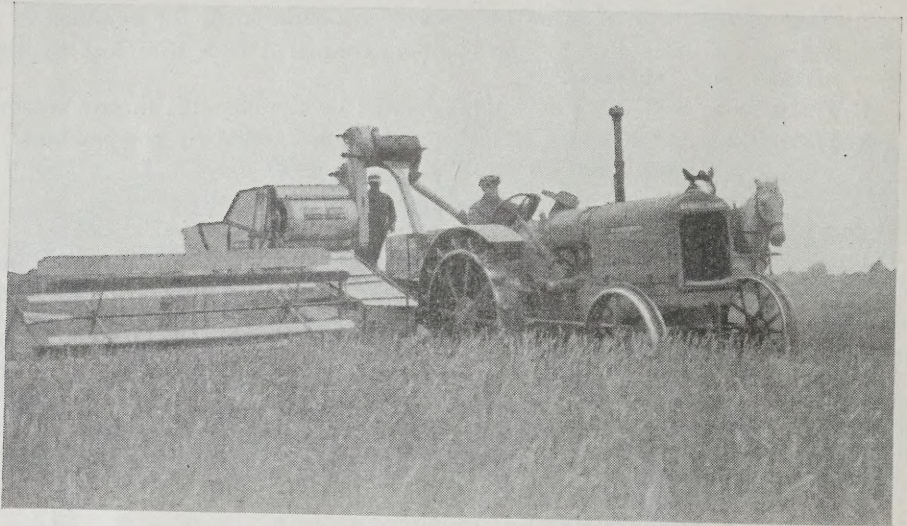
Interest, depreciation and repairs	\$20 70
Tractor and operator	21 00
Combine operator	10 00
Teamster and two horses drawing grain	4 60
Gasoline, grease and oil for combine	15 23
	<hr/>
	\$71 53
Cost per acre	\$ 1 64
Cost per bushel (in 20-bushel crop)	08

COST PER DAY OF A SIXTEEN-FOOT COMBINE WHEN DRAWN BY TWELVE HORSES, CUTTING 35 ACRES PER DAY AND OPERATING 20 DAYS PER SEASON

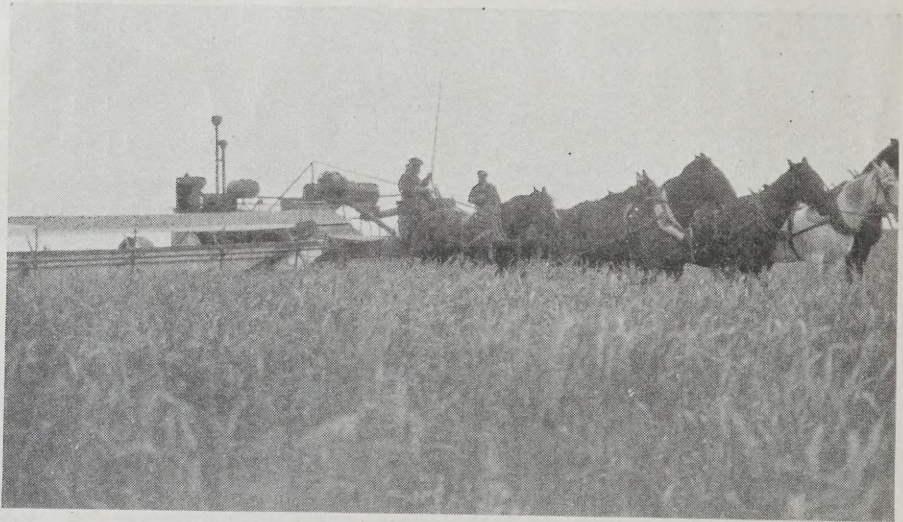
Interest, depreciation and repairs	\$20 70
Teamster and twelve horses	15 60
Combine operator	10 00
Teamster and two horses drawing grain	4 60
Gasoline, grease and oil	12 25
	<hr/>
	\$63 15
Cost per acre	\$ 1 80
Cost per bushel (in twenty-bushel crop)	09

On rolling land and where the soil is loose a 15-30 horse-power tractor would have difficulty in pulling a sixteen-foot combine and a loaded wagon. A larger tractor would be necessary under such conditions and might make the cost per acre of the tractor-drawn machine as high as that of the horse-drawn machine.

Harvesting with the binder and separator cost approximately 17 cents per bushel for a twenty-bushel crop. This was considerably higher than the costs of combine harvesting, which, according to the figures given above, were 8 and 9 cents per bushel.



Combine with the power take-off.



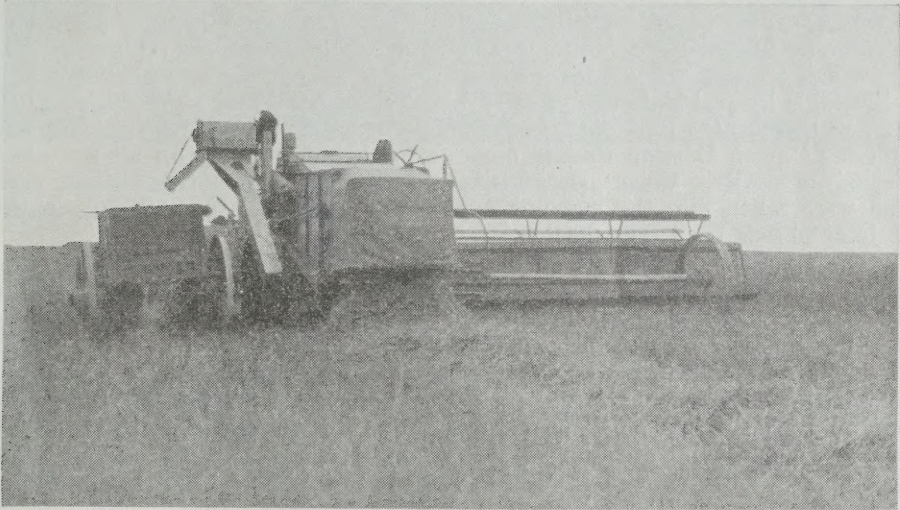
Combine drawn by horses.

STAGE OF MATURITY OF CROP FOR SUCCESSFUL OPERATION OF THE COMBINE

In order that the grain might reach sufficient maturity to keep without loss from heating, bin-burning, or from being graded as damp or tough, it was found necessary to let the crop stand ten to fifteen days after the time the binder could have been used. If the harvest weather were warm and dry this period might be shortened to eight days, while cold, damp weather together with a thin stand might lengthen the waiting period to twenty days.

An attempt was made to shorten the waiting period and eliminate a portion of the risks of loss. Ten acres of crop were cut by the combine six days later than the time the binder could have been used. Similar areas were cut at four-day intervals until the crop was undoubtedly fit to cut with the combine without any subsequent handling of the grain. The wheat from these various cuttings was handled as follows:—

- (1) Placed in heaps on the ground.
- (2) Placed in ventilated bins.
- (3) Passed through dehydrator.



Rear view of the combine.

Through the courtesy of the International Harvester Corporation, a grain dehydrator was set up at the Swift Current Station. This machine had an engine-driven blower which blew the grain up to a small elevated tank, from which it ran down to a large ventilated bin. The grain could be taken from this bin, blown up to the tank again and allowed to run down to a similar bin. The grain could be shifted from one bin to the other by this means as often as necessary.

The first cutting had a moisture content of 24.9 per cent. After being passed through the dehydrator fifteen times in a space of twelve days the moisture content was reduced to 23.5 per cent. A portion of this cutting which was placed in a heap on the ground and shovelled over repeatedly, showed no reduction in moisture. It finally moulded and became unfit for sale.

Four days later 300 bushels of combine-harvested grain was placed in the dehydrator and 300 bushels in the ventilated bin. Eight dehydrations reduced the moisture content from 20.5 per cent to 19.5 per cent. The ventilated bin made a slightly poorer showing.

Before the date of the third cutting, four days later, the moisture content of the standing grain fell from 20.5 per cent to 15 per cent or less. This grain kept without any treatment. Grain containing over 15.5 per cent of moisture usually has 3 per cent or more of green kernels. Even when the moisture can be reduced to 14.5 per cent these kernels remain green in colour and cause a reduction in grade.

It is evident that the only safe rule to follow in combine harvesting is to wait until the majority of the grains are dry and hard. Too early harvesting results in a loss. Standing grain loses moisture very quickly in warm, windy weather. Cutting a day, or even a half-day too soon, may mean the difference between straight grades and tough.

COMPARISON OF THE COMBINE WITH BINDER AND SEPARATOR IN REGARD TO GRAIN LOSSES

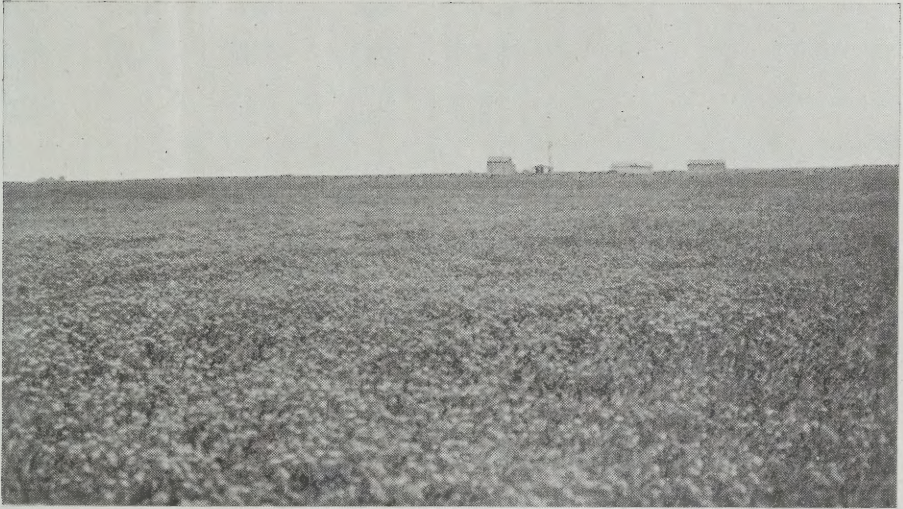
This comparison was made under circumstances very unfavourable to the combine. The wheat on fallow had been badly injured by root-rot and the crop had become very weedy. The second-year wheat crop was damaged to an extent of over 50 per cent by sawfly and had a great quantity of green Russian thistles in it. The combine was equipped with extension guards spaced six inches apart. The tangled mass of heads and broken straw was swept back to the table by reel slats equipped with small fingers set at right angles to the slats, and so located that they passed between the extension guards. The large amount of green Russian thistles made it impossible to pick up all the wheat affected by sawfly. When close cutting was attempted, quantities of the green weed were taken into the machine and it was impossible to entirely separate the juicy shreds from the wheat.

The amount of grain left on the ground behind the combine table was determined by means of counting at frequent intervals all the kernels found within limited areas. All the straw, chaff and grain coming over the screens at the rear of the combine were collected from certain definite areas.

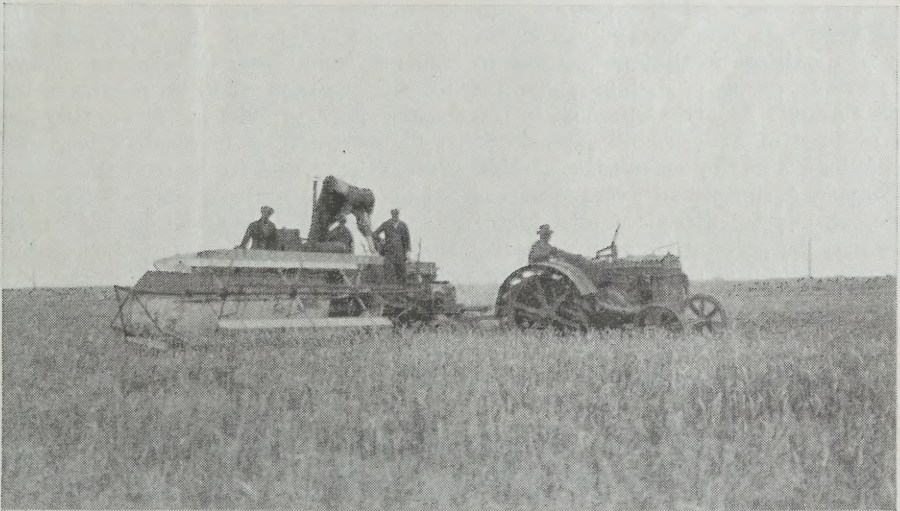
The binder used in the test was equipped with a canvas suspended beneath the binder-attachment and the sheaf-carrier in order to catch all unbound heads and shelled kernels. The sheaves were dumped and stooked on canvas squares. The amount of grain lost behind the binder-knife was determined by counting small defined areas. Measurements were made of all grain lost on the bundle-racks, at the feeder and in the separator. The following tables give the actual results obtained in bushels per acre:—

LOSSES OF WHEAT IN BUSHELS PER ACRE: CROP CUT WITH BINDER, THRESHED FROM STOOK

Field	At Carrier	At Stook	On Rack	At Feeder	In Separator	Left on ground	Total Loss per acre	Net Yield per acre	Percentage Loss
	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.	
Wheat on fallow.....	0.4947	0.5440	0.1320	0.1312	0.1040	1.660	3.0659	19.50	13.58
Wheat on fallow.....	0.2250	0.5536	0.1665	0.0692	0.1040	1.560	2.6783	15.25	14.95
Wheat on fallow.....	0.3470	0.5780	0.2104	0.1445	0.1040	0.571	1.9549	12.50	13.53
Wheat on stubble.....	0.3860	0.0490	0.0600	0.0536	0.1040	2.500	3.1526	3.44	47.84
Wheat on stubble.....	0.4100	0.0440	0.1260	0.0450	0.1040	1.040	1.7690	4.92	26.45
<i>Averages</i>									
Wheat on fallow.....	0.3556	0.5585	0.1696	0.1150	0.1040	1.264	2.5660	15.75	14.02
Wheat on stubble.....	0.3980	0.0470	0.0930	0.0493	0.1040	1.770	2.4600	4.18	37.20



Early stage of a weedy crop of wheat which was later cut by the combine.



The combine cutting the weedy crop shown in the picture above. Note the fingers on the reel-slats.

LOSSES OF WHEAT IN BUSHELS PER ACRE, CROP HARVESTED WITH COMBINE

Field	At End Gate	Left on ground	Total Loss per acre	Net Yield per acre	Percentage Loss
	Bush.	Bush.	Bush.	Bush.	
Wheat on fallow.....	0.2985 0.1864	2.1460 2.9860	2.4400 3.1724	5.360 7.600	13.00 15.28
Wheat on stubble.....	0.1920 0.1680	4.1756 3.0620	4.3676 3.2200	6.550 6.380	40.00 33.54
<i>Averages</i>					
Wheat on fallow.....	0.2424	2.5660	2.8060	16.980	14.14
Wheat on stubble.....	0.1800	3.6188	3.7900	6.465	36.75

There was very little difference in the amounts of grain lost by either method of harvesting, but it must be remembered that the conditions were very unfavourable to the economical operation of the combine. A casual observation before harvesting indicated the impossibility of saving more than 50 per cent of the crop.

In a clean, undamaged crop the combine would save as much and possibly more grain than would the binder and separator.

ACREAGE THAT CAN SAFELY BE HARVESTED BY A FIFTEEN OR SIXTEEN-FOOT COMBINE IN A SEASON

Replies to questionnaires dealing with the combine 1. from owners each year since 1924. The following conclusions maximum acreage for one combine are based partly on the and partly on the weather records obtained on the Swift Current Station.

The average starting date of combines in Saskatchewan was August 24, and the average closing date was October 2. Number of days lost in that period due to rain and snow, was 18 of 16 days, exclusive of Sundays, on which the combine could not operate. Between August 24 and October 2 in the seasons 1922 to 1925 in an average of 31 combine-days at Swift Current. It is reasonable that in an average season the combine can be expected to operate 24 days. Assuming an average acreage of 35 acres per day a combine can harvest 840 acres. In 1926 the average daily area harvested this may be accounted for by the fact that the great majority were in their first season and that practically no time was lost

received the safe experience Station.

Alberta in 1926 average number of days operating. Because, there was no reason to assume for at least a 15-foot combine 1.7 acres but the combines breakdowns.

MILLING AND BAKING TESTS OF COMBINE WHEAT

Baking and milling tests of combine-harvested wheat were made, in comparison with binder-harvested wheat from the same field, in the Dominion Grain Research Laboratory in Winnipeg. In only one year was the loaf baked from binder wheat superior in texture and volume to that of combine wheat. In 1924 the combine wheat produced a decidedly better loaf. In all other cases there was practically no difference either in milling or in baking qualities.

GENERAL EXPERIENCES OF COMBINE OWNERS

Four privately owned combines were used in Saskatchewan in 1924, seventeen were in use in Saskatchewan and Alberta in 1925, and 146 were used in Saskatchewan, 26 in Alberta and 2 in Manitoba during the harvest season of

1926. Questionnaires on the operation of the machine were submitted to all owners. Over 100 combine owners were visited during the harvest season. The following is a summary of the 86 replies received:—

1. TYPES OF COMBINES USED

- 28 machines were drawn by horses in outfits of 8 to 12 h. d.
- 55 machines were drawn by tractors ranging in draw-bar horse-power from 10 to 20. The majority had a rated draw-bar horse-power of 15 to 16.

2. TIME LOST DURING HARVEST

- 45 machines lost an average of 18 days by reason of bad weather.
- 2 machines lost no time from unfavourable weather.
- 21 machines lost an average of 1.2 days waiting for repairs.
- 34 machines lost no time for repairs.

3. COST OF OPERATING THE COMBINE

- 53 owners gave an average estimated cost for wheat of 99 cents per acre. (These costs were for gas, oil and labour only).
- 33 owners kept no record of costs.
- 55 owners gave an average cost per bushel of wheat of 6 cents. (These costs were based on the same consideration as the acre cost).

4. COMBINE COMPARED WITH BINDER

- 35 owners gave an average saving of 10½ cents per bushel of wheat as compared with the binder and separator.
- 12 owners reported a saving of grain averaging 2.96 bushels per acre.
- 1 owner condemned the combine.
- 17 owners received better grades for combine-harvested grain than for binder-harvested grain.
- 51 reported that combine grades equalled binder grades.
- 8 received lower grades for combine grain.
- 9 made no comparison of grades.

5. AREA HARVESTED

- 84 owners reported a total area harvested by combines in 1926 of 53,366 and an average of 635.3 acres for each machine. The individual areas ranged from 50 to 2,260 acres.

6. SAWFLY DAMAGE

- 11 owners found that the combine picked up more sawfly-cut wheat than did the binder.
- 18 owners reported no damage from the sawfly.
- 40 owners reported a slight damage from this insect.
- 5 owners reported heavy damage from the sawfly.
- 9 owners stated that the sawfly loss was no greater than where binders were used.
- 1 owner found the sawfly loss greater than it would have been had he used the binder.

7. WEEDS

- 43 operators found that weeds gave a slight amount of trouble in their combine harvesting operations.
- 2 operators found that the green weeds plugged the sieves and occasioned some loss of grain.
- 2 operators had tough grain resulting from the inability of the combine to separate green weeds from the threshed grain.
- 14 operators reported no trouble from weeds.
- 2 men who operated combines in 1925 reported that the burning of combine stubble and straw rendered the succeeding crop free of weeds.
- 2 operators stated that they had an increased yield of 2 to 6 bushels per acre due to burning the combine stubble.



The combine cutting fall rye.

LAND PREPARATION AND METHODS OF SEEDING FOR COMBINE HARVESTING

In districts where short crops occur, it is necessary to have a smooth seed-bed, free from stones. If the seed-bed has been heavily ridged with the disk-harrow the combine cannot cut close. Stones are a serious menace in short crops. Large stones may break the pitman, knife or guards. Smaller stones may be thrown on the canvas and taken into the cylinder, causing considerable damage and loss of valuable time.

Low spots that usually remain green when the remainder of the field has ripened should be double-seeded to hasten ripening.

Any practice that will destroy weeds and reduce sawfly damage should be followed. A combination of sawfly-cut wheat and green weeds constitutes the most serious menace to the successful operation of the combine.

In localities where wheat normally ripens late, it is possible by using either early ripening varieties or a heavier rate of seeding, to hasten the date of harvesting with the combine by a week or more.

SUGGESTIONS ON THE OPERATION OF THE COMBINE

The crop should be cut as high as possible without missing heads.

The wind should be regulated to conform to the volume of grain coming in. Frequent and complete oiling of all bearings is more necessary in the combine than any other farm machine. Oiling reduces the risk of a breakdown. One day wasted while waiting for repairs may mean the loss of 40 acres of crop.

The pre-seasonal overhauling of the combine is a vital matter. When the crop is ready to harvest with the combine, it is essential that harvesting be done with the least possible delay. In order to avoid a possible shortage of repair parts during harvest, overhauling should be done earlier in the summer.

GENERAL CONCLUSIONS

(1) The minimum acreage for which a combine is purchased should not be less than 300 acres. If the purchaser intends doing custom work, a smaller acreage of his own would justify the purchase of a machine. Several owners did custom work in 1926. The charges varied from \$2.50 to \$3.50 per acre.

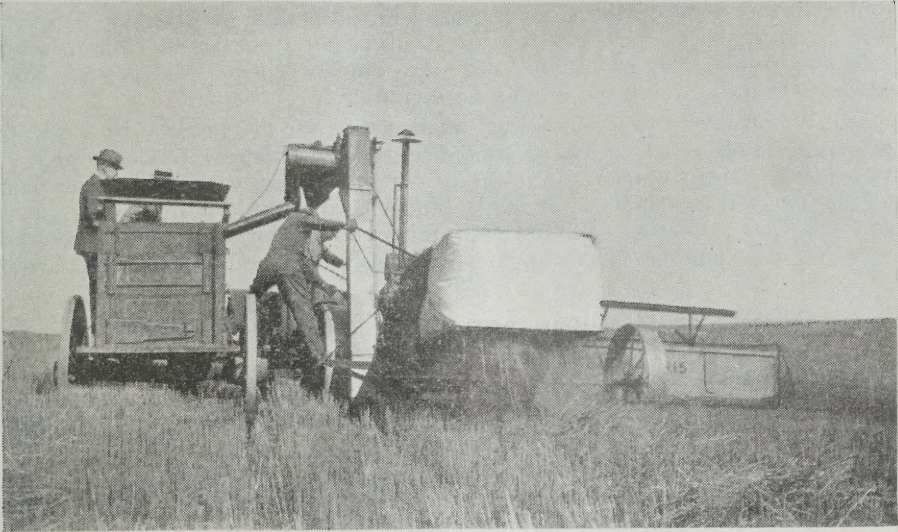
(2) The maximum acreage for a combine in one season cannot safely be placed above 800 to 1,000 acres. A few operators have reported as much as 2,000 acres cut by one combine in a season.

(3) The waiting period between binder harvesting and combine harvesting may vary from eight to twenty days, depending on climatic conditions.

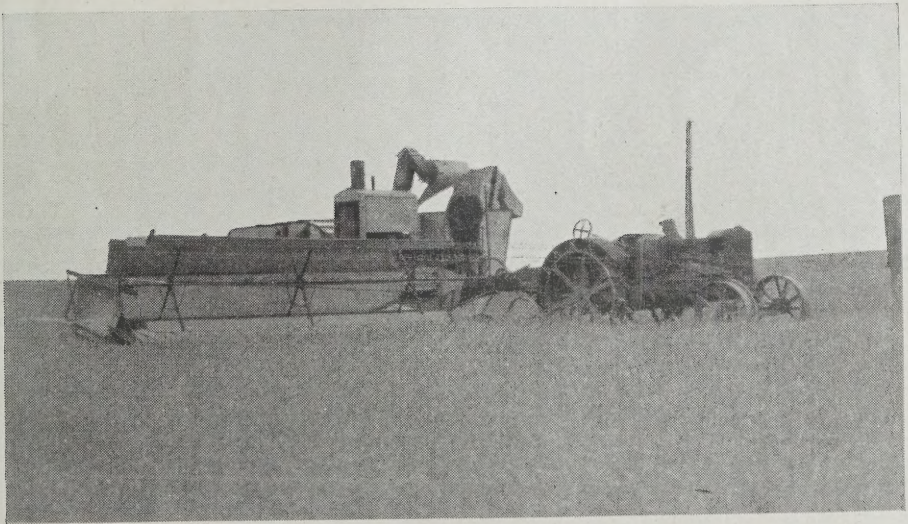
(4) With Marquis wheat there is usually very little additional loss from shelling by waiting until the proper time to harvest with the combine. Any loss sustained is generally offset by the smaller loss incurred in handling the crop with the combine.

(5) Sawfly-damaged wheat can be picked up as well by the combine as by the binder. The only apparent cause of loss from using the combine would be in the case of a thin crop infested with green weeds. If the harvest season were wet and warm, the green weeds would grow rapidly. This would make combine harvesting difficult and might dampen the grain. Early cutting with the binder would avoid this trouble.

(6) A heavy crop flattened out by storms can be harvested more easily by the combine than by the binder. As such a crop is usually free from weeds, the table can be set low enough to pick it up. By travelling slowly, overloading of the threshing mechanism can be avoided.



The combine in a heavy crop.



The combine in a light crop.

(7) In general a bad season for the combine is also a bad season for the binder and separator. Following a rain the combine can be started sooner than the separator, because standing grain dries out in less time than stooked grain. Wheat harvested by the binder, early in August on the Swift Current Station, sprouted in the stook during the wet period in the middle of August. A portion of the same field was harvested by the combine after the rains. The combine wheat was graded No. 2 straight and the binder wheat was graded No. 3 straight. On other fields the grades were similar.

(8) Wet weather causes a reduction in grade for all wheat. In a favourable season combine wheat would probably grade as high as binder wheat. It is possible that in a season of unusually early and heavy snowfall some combine grain would be snowed in, while binder grain would be standing in the stook. In such a case the combine grain might be a total loss. Apart from this eventuality the combine can compete favourably with the binder and separator.

POINTS TO BE CONSIDERED BEFORE BUYING A COMBINE

The land must be reasonably level.

The land must be of such a character that the crop ripens with a fair degree of uniformity.

A person of proven mechanical ability must be available to operate the combine. While the combine is not more difficult to operate than the separator, the necessity for continuous operation in the harvest season is even greater.

It has not been proven conclusively that the combine will handle any grain crop in any season. In a normal season it will cut and thresh wheat, oats, barley, fall rye, and flax at a considerable saving over the binder and separator. In an abnormal season such as 1926, the same is true, but it must not be forgotten that an unusual combination of climatic conditions, weeds and pests may make the operation of the combine wasteful or even impossible.

